Line Production Estimating Guides for Fire Behavior Fuel Models

R. Gordon Schmidt and George C. Rinehart

Respectively, Forester, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., and Fuels Management Specialist, USDA Forest Service, Payette National Forest, McCall, Idaho.

Line production estimating guides are needed for initial action planning and estimating control forces required on project fires. Current methods of predicting fire behavior in these situations use fire behavior fuel models (*1*). This article provides line production estimating guides for fuel conditions represented by fire behavior fuel models.

Present methods of estimating line construction rates are best guesses or nomograms constructed from Hornby's adjective fuel rating system. These methods are somewhat outdated because they are not linked to current fuel classification schemes used by fire behavior officers, and they are limited to four fuel conditions.

The tables in this report provide line construction rates covering a wider range of fuel types than past methods and are linked to fire behavior fuel models used in fire suppression work.

These tables have been developed by matching the fuel conditions represented by National Fire Danger Rating System (NFDRS) (*2*) fuel models to similar fuel conditions represented by fire behavior fuel models using Anderson's similarity chart.[1]

The NFDRS fuel model line construction rates are published in Fire Management Analysis and Planning Handbook (*3*).

Limitations

The NFDRS fuel model rates were developed by several people familiar with each fuel type. They were prepared for planning purposes and, therefore, have not been field tested. The fire behavior fuel model rates presented here are suggested for a beginning and should be revised as needed. A knowledgeable local individual should be able to adjust these rates to match local conditions.

The production rates reflect only fuel conditions and do not reflect influences of topography or fire behavior.

The Tables

The tables give line construction rates for hand crews, pumper crews, and bulldozers for each fire behavior fuel model. Rates for initial action and sustained line construction are provided. Where a

Table 1.—*Line production rates for initial action by hand crews* [1]

Fire behavior fuel model	Conditions used in	Construction rate
		Chains per person-hour [2]
1 Short grass	Grass	4.0
	Tundra	1.0
2 Open timber/ Grass understory	All	3.0
3 Tall grass	All	0.7
4 Chaparral	Chaparral	0.4
	High pocosin	0.7
5 Brush (2ft.)	All	0.7
6 Dormant brush/ hardwood slash	Alaska black spruce	0.7
	All others	1.0
7 Southern rough	All	0.7
8 Closed timber litter	Conifers	2.0
	Hardwoods	10.0
9 Hardwood litter	Conifers	2.0
	Hardwoods	8.0
10 Timber (litter and understory)	All	1.0
11 Light logging slash	All	1.0
12 Medium logging slash	All	1.0
13 Heavy logging slash	All	0.4

[1] These rates are to be used for estimating initial action productivity only. Do not use these rates to estimate sustained line construction, burnout, and holding productivity. Initial action consists of scratch line construction and hotspotting.

[2] 1 chain/hr is equivalent to 20.1 meter/hr.

[1] Anderson, Hal E. Aids to determining fuel models for estimating fire behavior. Gen. Tech. Rept. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station; in press.

fuel model can be used in two different situations, rates are given for each. For example, fire behavior fuel model 8 represents fuel conditions expected in compact timber litter, either hardwood or conifer. However, line construction rates in hardwood litter are different from those in conifer litter, so both rates are provided.

Tables 1 and 2 show line production, given a fire behavior fuel model, in chains per hour for initial action for hand crews and pumper crews. These rates should not be used to estimate sustained

line construction, burnout, and holding. Initial action rates consider only scratch line construction and hotspotting.

These rates may be used for dispatch planning in a planned area for estimating initial action.

Table 3 contains the line construction, burnout, and holding rates, given a fire behavior fuel model, in chains per 20-person crew hour. These rates are for sustained production over a 12-hour shift on the line. They account for cumulative fatigue and rest periods.

Production rates per person hour are presented parenthetically for estimating production of crews varying from the 20-person standard.

The rates are given in the two crew categories used by the Forest Service. The categories are defined in the footnote to table 3.

These rates may be used to determine control forces required on project fires.

Table 4 contains line construction rates for bulldozers given a fire behavior fuel model and percent slope, in chains per machine hour. These rates do not include burnout and holding of line.

Bulldozer sizes are expressed as Caterpillar models; equivalent models of other makes may use the same rates.

These rates may be used to determine bulldozer needs on project fires.

Conclusions

These estimating guides should prove useful to firefighters in their planning efforts.

When using these guides remember their limitations: The rates are generalized and may need adjustments; A knowledgeable local person may be needed to make adjustments.

Table 2.—*Line production rates for initial action by pumper crews* [1]

Fire behavior fuel model	Conditions used in	Rates in chains per crew-hour				
		Number of persons in crew				
		1	2	3	4	5+
1 Short grass	Grass	6	12	24	35	40
	Tundra	2	8	15	24	30
2 Open timber/ Grass understory	All	3	7	15	21	25
3 Tall grass	All	2	5	10	14	16
4 Chaparral	Chaparral	2	3	8	15	20
	High pocosin	2	4	10	15	18
5 Brush (2ft.)	All	3	6	12	16	20
6 Dormant brush/ hardwood slash	Black spruce	3	6	10	16	20
	All others	3	6	12	16	20
7 Southern rough	All	2	5	12	16	20
8 Closed timber litter	Conifers	3	8	15	20	24
	Hardwoods	10	30	40	50	60
9 Hardwood litter	Conifers	3	7	12	18	22
	Hardwoods	8	25	40	50	60
10 Timber (litter and understory)	All	3	6	12	16	20
11 Light logging slash	All	3	8	12	16	20
12 Medium logging slash	All	3	5	10	16	20
13 Heavy logging slash	All	2	4	8	15	20

[1] These rates are to be used for estimating initial action productivity only. Do not use these rates to estimate sustained line construction, burnout, and holding productivity. Initial action may consist of scratch line construction and hotspotting.

Table 3.—*Sustained line production rates of 20-person crews for construction, burnout, and holding* [1]

Fire behavior fuel model	Conditions used in	Crew category [2]	
		I	*II*
1 Short grass	Grass	30 (1.50) [3]	18 (0.90)
	Tundra	9 (0.45)	5 (0.25)
2 Open timber/ grass understory	All	24 (1.20)	16 (0.80)
3 Tall grass	All	5 (0.25)	3 (0.15)
4 Chaparral	Chaparral	5 (0.25)	3 (0.15)
	High pocosin	4 (0.20)	2 (0.10)
5 Brush (2ft.)	All	6 (0.30)	4 (0.20)
6 Dormant brush/ hardwood slash	Black spruce	7 (0.35)	5 (0.25)
	Others	6 (0.30)	4 (0.20)
7 Southern rough	All	4 (0.20)	2 (0.10)
8 Closed timber litter	Conifers	7 (0.35)	5 (0.25)
	Hardwoods	40 (2.00)	24 (1.20)
9 Hardwood litter	Conifers	28 (1.40)	16 (0.80)
	Hardwoods	40 (2.00)	24 (1.20)
10 Timber (litter and understory)	All	6 (0.30)	4 (0.20)
11 Light logging slash	All	15 (0.75)	9 (0.45)
12 Medium logging slash	All	7 (0.35)	4 (0.20)
13 Heavy logging slash	All	5 (0.25)	3 (0.15)

[1] Allowances have been made in production rates for rest periods and cumulative fatigue.
[2] Crew category I is Inter-regional hotshot crews; II is all others including FS regular crews.
[3] Chains per person-hour are shown in parentheses.

Table 4.—*Sustained line production rates, bulldozer construction*

Fire behavior fuel model	Conditions used in	Percent slope [1] - Bulldozer size [2]											
		0 to 25 percent			26 to 40 percent			41 to 55 percent			56 to 74 percent		
		S	M	L	S	M	L	S	M	L	S	M	L
		Chains per machine-hour											
1 Short grass	Grass	70	75	100	54	60	90	40	44	80	24	28	60
	Tundra	[3]	—	—	—	—	—	—	—	—	—	—	—
2 Open timber/	Conifers	35	39	50	27	30	45	20	22	40	12	14	30
grass understory	Brush-grass	70	78	100	54	60	90	40	44	80	24	28	60
3 Tall grass	All	23	25	40	18	20	35	13	15	30	5	7	25
4 Chaparral	Chaparral	35	43	50	27	30	45	20	22	40	12	14	30
	High pocosin	—	—	—	—	—	—	—	—	—	—	—	—
5 Brush (2ft.)	All	23	25	40	18	20	35	13	15	30	5	7	25
6 Dormant brush/	Black spruce	28	30	40	22	25	35	18	20	30	10	12	20
hardwood slash	Others	23	25	40	18	20	35	13	15	30	5	7	25
7 Southern rough		—	—	—	—	—	—	—	—	—	—	—	—
8 Closed timber litter	Conifers	28	30	40	22	25	35	18	20	30	10	12	25
	Hardwoods	22	26	30	19	21	27	16	18	17	5	8	9
9 Hardwood litter	Conifers-West	35	39	50	27	30	45	20	22	40	12	14	30
	South	23	25	40	18	20	35	13	15	30	5	7	20
	Hardwoods	22	26	30	19	21	27	16	18	17	5	8	9
10 Timber (litter and understory)	All	23	25	40	18	20	35	13	15	30	5	7	25
11 Light logging slash	All	35	39	50	27	30	45	20	22	40	12	14	30
12 Medium logging slash	All	35	39	50	27	30	45	20	22	40	12	14	30
13 Heavy logging slash	All	23	25	40	18	20	35	13	15	30	5	7	25

[1] Machine use above 74 percent slope assumed infeasible.
[2] S denotes Small (D4-size) bulldozer; M denotes Medium (D6-size) bulldozer; L denotes Large (D7-size) bulldozer.
[3] Machine use assumed infeasible in these fuel types.

Literature Cited

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3. USDA Forest Service. Fire Management Analysis and Planning Handbook. FSH 5109.19, supplemented, Chapter 90:A-19-A-26. Unpublished draft. ■